The basic difference between the two methods is that the former (CRF) is essentially an accounting type of measure in that it considers only those items that will affect the financial statements of the firm, namely, interest and depreciation. The latter method is more of a "cash-flow" concept in that it examines all factors that will change the cash position of the firm, and as such, considers the tax shield provided by depreciation.

As will be noted below both methods are theoretically sound, however there do exist large differences related to the ease of use and understanding of each, and thus their values as decision-making tools differ.

In the sections that follow the capital costs of the control options are presented for the control technologies available. Next the CRF method is described and the annualized cost estimates derived from its use are presented. Also presented are the annualized cost estimates as made through the method used in the draft paper noted above. Following the presentation of annualized cost estimates is the comparison of cost-effectiveness results achieved by both methods. Finally, reasons for the differences in results are offered along with recommendations related to the estimation of annualized costs in the future.

Capital Control Costs

There are four facilities that may be affected by the Ohio quench tower pollution control options;

- o Republic Steel - Youngstown,
- o Republic Steel - Warren,
- o United States Steel - Lorain, and
- o Jones & Laughlin Steel - Campbell.

There are two basic control technologies available;

- o multi-row baffles, and
- o clean water quenching.

These are evaluated in the form of three control options;

- o installation of multi-row baffles
- o clean water quenching with existing (status quo) baffles, and
- o installation of multi-row baffles and clean water quenching.

The last control option is evaluated in terms of the incremental costs and emissions reductions estimated for the addition of clean water quenching if multi-row baffles are already in place.

The capital costs for both types of control at the four sites are presented in Table 1.

Table 1
Capital Costs
($ thousands, 1981)

	Clean Water Quenching[a]	Multi-Row Baffles[b]
Republic - Youngstown	3,706.2	678.0
Republic - Warren	3,302.3	678.0
USSC - Lorain	4,913.6	1,288.3
J&L - Campbell	4,134.9	---[c]

[a]Source: Effluent Limitations Guidelines Document for Iron and Steel, with adjustments for flow rates and inflation.

[b]Source: Cost-Effectiveness Analysis of Ohio Quench Tower Pollution Control Options, page 5, with adjustment for future capital costs due to baffle replacement.

[c]Multi-Row Baffles exist at J&L - Campbell.

The capital costs for Clean Water Quenching are virtually indentical to those in the referenced Cost-Effectiveness Analysis. Because the costs presented in that document are in 1978 dollars, they have been updated by a factor of 1.357 derived from the Chemical Engineering Plant Cost Index, where 1978 = 218.8 and 1981 = 297.0.

For the purpose of the CRF analysis that follows the capital costs for Multi-Row Baffles are those presented in the referenced document, along with the addition of the present value of future capital expenditures (i.e., baffle replacement) required at four-year intervals. The Cost-Effectiveness Analysis notes that the four-year expenditures required for baffle replacement are about 40 percent of the original investment, and in that analysis such costs are treated as expenses in the year in which they occur. However, current tax laws permit the capitalization (thus depreciation) of capital expenditures that "substantially extend the useful life of property."[1] Furthermore, "expenditures as part of a general plan of reconditioning, rennovating, improving, or altering property must be capitalized even though certain portions of the work standing alone might be properly classifiable as repairs."[2]

Table 2 summarizes the determination of the capital costs for multi-row baffles. As noted, such costs have two components, the original capital costs, along with an estimate of the present value (discounted at 11.23 percent or the cost of debt used in the estimation of the CRF)[3] of the four-year baffle replacements discussed above.

Table 2

Total Capital Costs for Multi-Row Baffles

($ thousands, 1981)

	Original Capital Costs	Present Value of Replacements	Total Capital Costs
Republic - Youngstown	400.0	278.0	678.0
Republic - Warren	400.0	278.0	678.0
USSC - Lorain	760.0	528.3	1,288.3
J&L - Campbell	-	-	-

Annualized Costs Under CRF

The capital recovery factor (CRF) is estimated by:

$$CRF = \frac{r\,(1 + r)^n}{(1 + r)^n - 1}$$

where;

r = rate of interest on borrowed funds,

n = life of both the loan and the equipment installed.

Because the control equipment can be financed through the issuance of air pollution control Industrial Development Bonds at an approximate current rate of 11.23 percent,[3] and because the life of both the bond and control equipment is 25 years, the CRF in this case is:

$$CRF = \frac{.1123(1.1123)^{25}}{(1.1123)^{25} - 1} = .1207$$

In the determination of the CRF above, the nominal rate (i.e., unadjusted for inflation) of interest is used. The use of this rate (11.23%) is justified because the CRF attempts to define the actual dollar amounts of interest and depreciation that will be paid by the affected steel companies. Furthermore, because the object of the CRF is to estimate the effect of the control expenditures on the firm's balance sheet and income statement, the estimation of costs in terms other than nominal amounts cannot be justified.

The CRF of .1207 can be applied directly to the capital costs noted in Table 1, to derive estimates of annual capital charges (i.e., interest and depreciation). These estimates are noted in Table 3.

Table 3

Annual Capital Charges

($ thousands, 1981)

	Clean Water Quenching	Multi-Row Baffles
Republic - Youngstown	447.3	81.8
Republic - Warren	398.6	81.8
USSC - Lorain	593.1	155.5
J&L - Campbell	499.1	-

Annual operating and maintenance costs are 17 percent of capital costs for Clean Water Quenching and zero for Multi-Row Baffles.[4] These annual costs are noted in Table 4.

Table 4

Annual Operating and Maintenance Costs

($ thousands, 1981)

	Clean Water Quenching	Multi-Row Baffles
Republic - Youngstown	630.1	0.0
Republic - Warren	561.4	0.0
USSC - Lorain	835.3	0.0
J&L - Campbell	702.9	-

The next step in the development of an annualized cost estimate through the CRF method is to recognize the positive benefits of the Investment Tax Credit (ITC). The current ITC is 10 percent of the capital investment, and is usually taken by firms in the first year the investment is made. However, in order to be consistent with the CRF method of cost annualization, the credit must be expressed in annual terms and deducted from the annualized cost estimate. This is accomplished by expressing the credit as an annuity (i.e., a series of payments of a fixed amount for a specified number of years) whose present value is the amount of the investment tax credit. The rate used to annualize the ITC is the same 11.23 percent used above. The annual value of the ITC is noted in Table 5.

Table 5

Annual Value of the Investment Tax Credit

($ thousands, 1981)

	Clean Water Quenching	Multi-Row Baffles
Republic - Youngstown	44.7	8.2
Republic - Warren	39.9	8.2
USSC - Lorain	59.3	15.6
J&L - Campbell	50.0	-

The final estimation of the annualized costs of each control option is made by adding the annual capital charges noted in Table 3, to the annual operating and maintenance costs of Table 4, and subtracting the annual value of the investment tax credit presented in Table 5. The results of this procedure are summarized in Table 6.

Table 6

Annualized Cost Estimates (CRF)

($ thousands, 1981)

	Clean Water Quenching	Multi-Row Baffles
Republic - Youngstown	1,032.7	73.6
Republic - Warren	920.1	73.6
USSC - Lorain	1,369.1	130.9
J&L - Campbell	1,152.0	-

Annualized Costs Under the Cash-Flow Method Used in "Cost-Effectiveness Analysis"

The annualized cost estimates reported in the Cost-Effectiveness Analysis draft, were obtained by determining the after-tax Net Present Value (NPV) of all cash flows related to the control expenditures, expressing the NPV as an annuity, and working back through the marginal tax rate to express the annualized costs on a before-tax basis. As noted above, this method is correct as applied in the draft, and the annualized cost estimates obtained are valid. These estimates are reported on pages 4 and 6 of the draft and are reproduced in Table 7 below. The costs of Table 7 are updated to 1981 to be consistent with those determined by the CRF method and noted in Table 6.

Table 7
Annualized Cost Estimates (Cash-Flow)
($ thousands, 1981)

	Clean Water Quenching	Multi-Row Baffles
Republic - Youngstown	866.2	85.6
Republic - Warren	771.8	85.6
USSC - Lorain	1,148.4	162.6
J&L - Campbell	970.5	-

Cost-Effectiveness Comparison

To estimate the cost-effectiveness of three control options the annualized cost of Tables 6 and 7 are divided by the Tons per Year (TPY) reductions achieved by those options. The TPY reductions possible are summarized in Table 8. The cost effectiveness estimates are presented in Table 9.

Table 8

Absolute and Incremental TPY Reductions

(~~$ thousands,~~ 1981)

Tons per year

	Republic Youngstown	Republic Warren	USSC Lorain	J&L Campbell
Absolute				
Current	1,740	1,440	2,385	1,170-1,825
Multi-Row Baffles	860	710	1,200-2,065	1,170-1,825
Clean Water Quenching	340	280	1,400	300-655
Multi-Row Baffles & Clean Water Quenching	250	210	400-870	300-655
Incremental Reduction				
Multi-Row Baffles	880	730	1,185-320	0-0
Clean Water Quenching	1,400	1,160	985	870-1,170
Multi-Row Baffles & Clean Water Quenching	610	500	800-1,195	870-1,170

Table 9

Cost-Effectiveness Ratios

($, 1981)

$/Ton reduced

Annualized Costs

	Clean Water Quenching	Multi-Row Baffles	Multi-Row Baffles to Clean Water Quenching
CRF			
Republic - Youngstown	738	84	1,694
Republic - Warren	793	101	1,840
USSC - Lorain	1,390	118-437	1,711-1,146
J&L - Campbell	1,324-985	-	1,324-985
Cash Flow			
Republic - Youngstown	618	97	1,420
Republic - Warren	665	117	1,544
USSC - Lorain	1,166	137-508	1,436-961
J&L - Campbell	1,116-830	-	1,116-830

As observed from Table 9, the CRF method gives cost-effectiveness levels for Clean Water Quenching that are about 19 percent higher than those gotten by the cash-flow method. It seems the major reason for this difference is that the latter method uses accelerated depreciation methods while the CRF is limited to straight-line depreciation. For Multi-Row Baffles the CRF estimates are 16 percent lower. This difference is due to the fact that the CRF method has capitalized all replacement baffles, and thus gained from higher amounts of Investment Tax Credit.

Choice of Method

Recognizing that both methods described above provide estimates of cost-effectiveness that are, in all cases, within 20 percent of each other, it is suggested that the CRF method be used in future assessments because it:

- is much easier to calculate, understand, and describe,
- is less subject to error because it avoids the need to project inflation and tax rates far into the future,
- provides relatively conservative estimates of annualized costs, and
- provides estimates, the accuracy of which are comparable with the accuracy of related control cost estimates (i.e., apparently within 20 percent).

For these reasons, it is felt that while the CRF method is admittedly a less sophisticated approach, it is a perfectly valid method under the context of its application. But perhaps the greatest reason for its use is that it is a simple approach that provides reasonably accurate results that are able to be understood by both the regulator as well as the regulated firm, regardless of the individuals' understanding of the techniques of financial analysis.

References

1. Research Institute Master Federal Tax Manual, 1981 Edition, New York, page 113.
2. Ibid. Page 135.
3. Rate reported by Standard & Poor's Corp. for 15 domestic municipal bonds for 1981. Reported in Survey of Current Business, April 1982, Vol. 62, No. 4, page S-16.
4. Cost-Effectiveness Analysis of the Ohio Quench Tower Pollution Control Options, page 2.